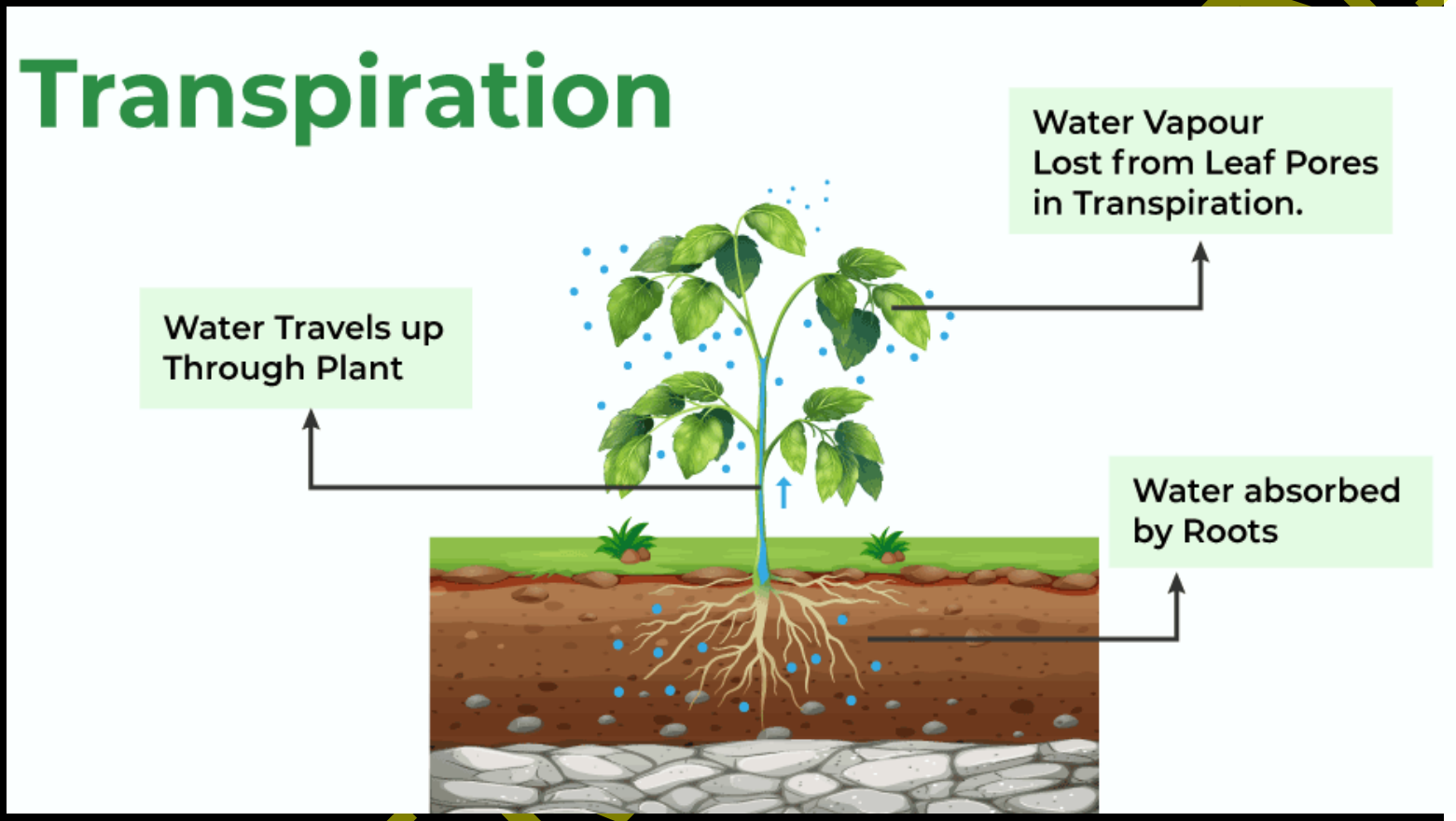
TRANSPIRATION

Transpiration is a very useful process for plants for two reasons:

one, creating suction force in the stem to enable the roots to absorb water and mineral nutrients,

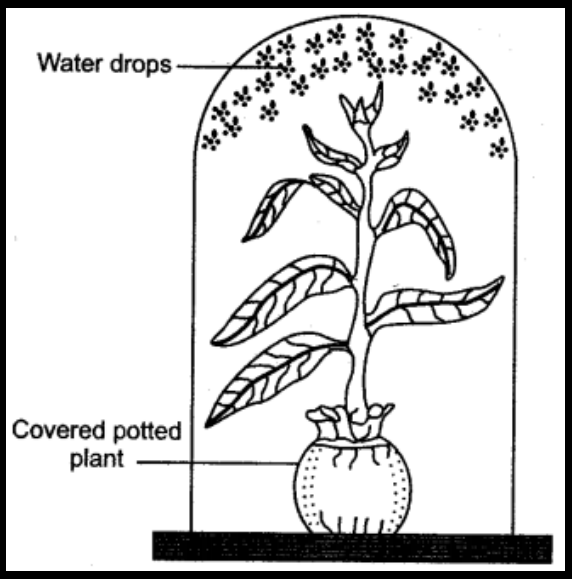
two, for cooling the plant in hot weather.



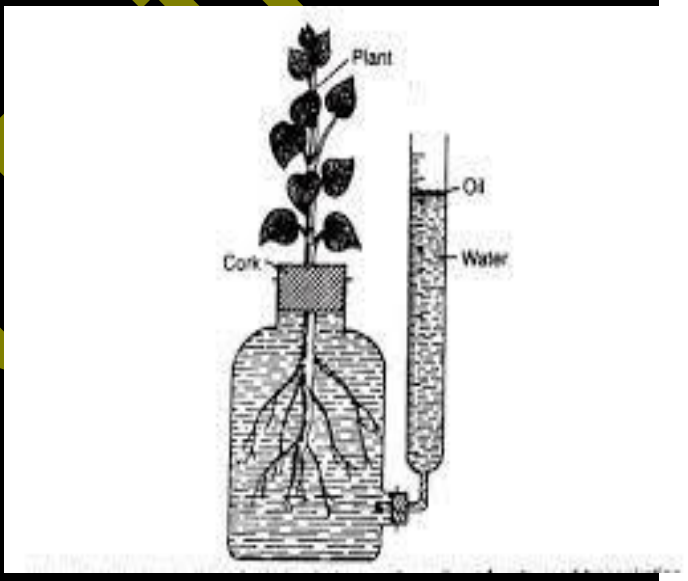
Transpiration is the process of loss of water in the form of water vapour from the leaves and other aerial parts of the plant.

98% of water intake is lost due to Transpiration and only 2% is used for Photosynthesis.

Experiment to show water is lost during Transpiration.



Experiment to show loss of water during transpiration can be measured.



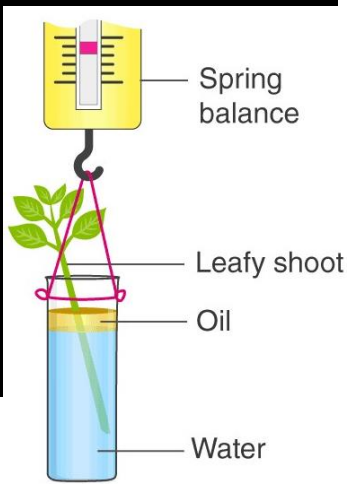
Blue Cobalt chloride changes ***to pink*** in presence of water.

Lost of water during Transpiration can be measured.

MEASUREMENT OF TRANSPIRATION

1. Weighing method: A small light weight potted plant can be weighed before and after the end of a certain period of time. This would indicate the volume of water loss that can be compared with the loss in weight with the help of a weighing machine .

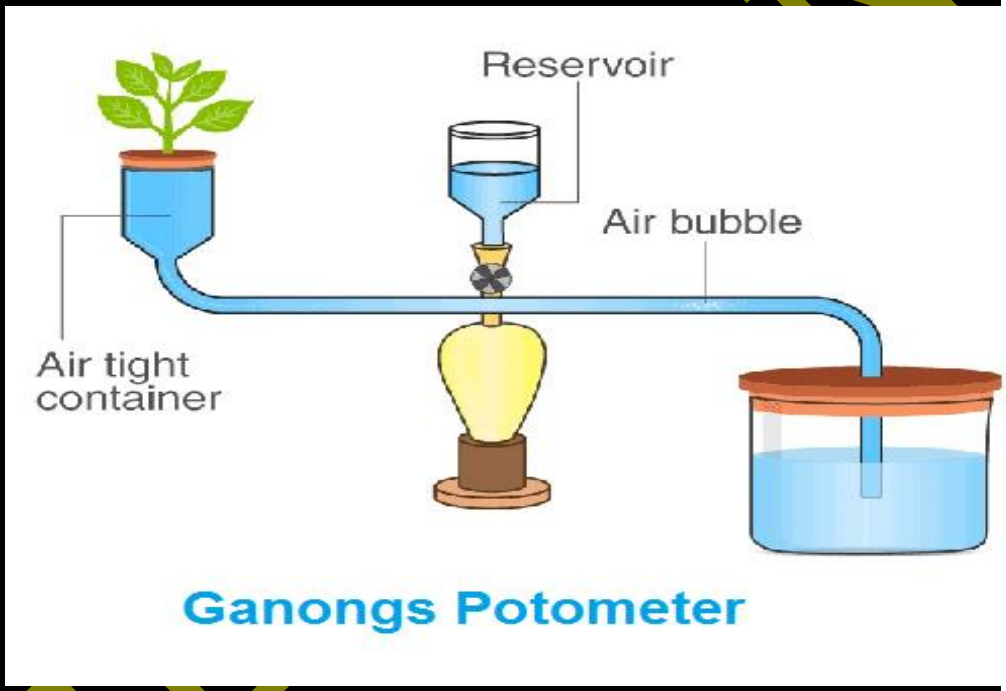
Another weighing experiment can be done by using a test-tube filled with water and inserting a leafy shoot (no roots) in it and pouring some oil on the surface to prevent loss of water by evaporation.



2. Potometer method: Potometer is a device that measures the **rate of water intake by a plant** (L. poton: drink, meter: measure), and this water intake is almost equal to the water lost through transpiration.

Ganong's Potometer :-

A twig of some suitable plant (e.g., coleus) cut with a sharp knife is fixed in an apparatus. The entire apparatus is filled with water so that no air spaces are present. The air bubble can be brought back to its original position by releasing some more water from the reservoir into the capillary tube by opening the stop cock.



Ganongs Potometer

Potometers do not measure the water lost during transpiration but measure the water uptake by the cut shoot.

Precautions in the use of potometer

(i) The potometer should be made completely water-tight.

(ii) The twig should be cut obliquely and under water to avoid suction of an air bubble into the twig which will stop the absorption of water into the xylem.

Limitations in the use of potometer

(ii) The twig may not remain fully alive for a long time.

(iii) Any changes in the outside air temperature may affect the position of the air bubble in the capillary tube.

KINDS OF TRANSPIRATION

Transpiration from the aerial parts of a plant occurs from three different regions :

(i) From the leaves through the stomata (*stomatal transpiration*),

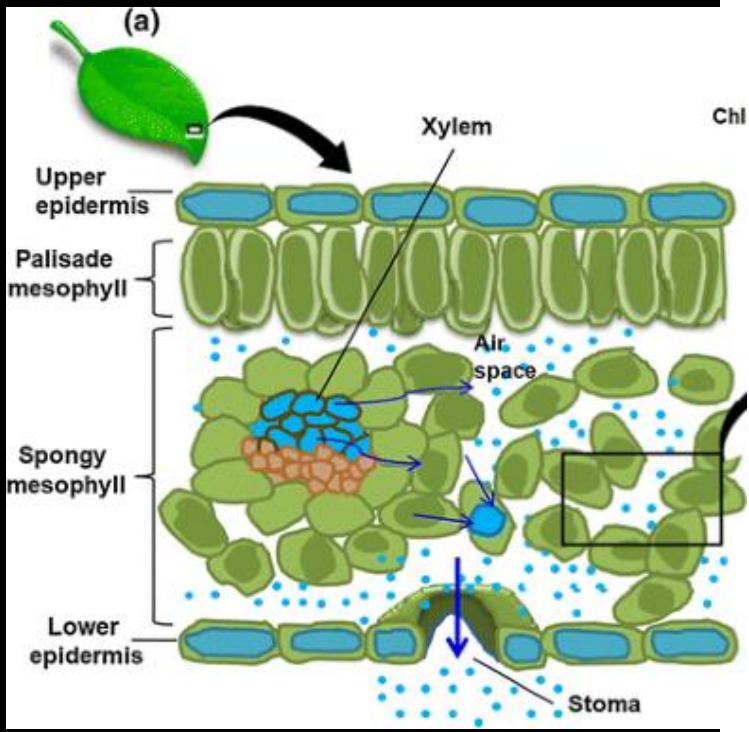
(ii) Directly from the surface of the leaves and stems. (Cuticular Transpiration)

(iii) From the lenticels which are the minute openings on the surface of old woody stems (lenticular transpiration).

Mechanism of Stomatal Transpiration

❖ Stomata (singular: stoma) are minute openings in the epidermal layer of leaves. A stoma is surrounded by two bean-shaped guard cells.

Water absorbed by roots reaches tissues of Leaf through veins. Intercelluar spaces get saturated with water and reaches sub stomatal space. Water molecules moves from HC to LC.



❖ The transpiration pull thus created can draw up water to about 50 metres or more in tall trees.

❖ More transpiration occurs from the under surface of a dicot leaf.

There are more stomatal openings on the undersurface of a dicot

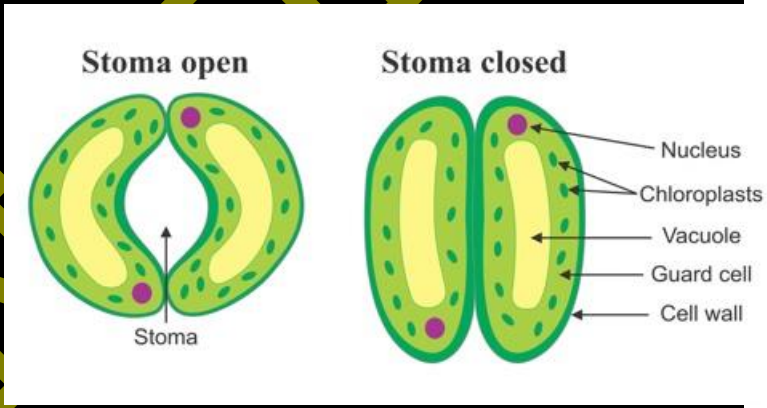
leaf and therefore, more transpiration occurs from the undersurface.

❖ **Experiment :** The leaf should remain attached to its own plant. The piece of paper which is facing the upper surface of the leaf either does not turn pink or turns pink in a much longer time than the one on the lower surface which turns pink much faster.

Stomatal regulation of transpiration

Stomata are minute structures occurring in large numbers on the *lower epidermis of a leaf*. The opening and closing is regulated by amount *of water and solutes* present in the **guard cells**.

Leaves of some plants wilt during midday and recover in the evening. In such cases, the rate of *transpiration during midday exceeds the rate of absorption* of water by the roots. The cells, therefore, lose turgidity.



Difference between Stomatal cuticular and lenticular transpiration

Stomatal transpiration is controlled by the plant by adjusting the size of the stoma, whereas this does not happen in the case of cuticular and lenticular transpiration.

❖ Stomatal transpiration accounts for about 85 – 90 % of water loss while lenticular transpiration is responsible for about 0.1% of the total transpiration loss and cuticular transpiration is responsible for about 5 – 10 % of the total transpiration.

❖ Stomatal transpiration happens only during daytime while both lenticular and cuticular transpiration happen throughout day and night.

Cuticular transpiration

Cuticle is a waxy layer secreted by the epidermis on the two surfaces of the leaf.

- The cuticle serves to prevent evaporation of water from the leaf surfaces.
- The greater the thickness of the cuticle, the lesser is the evaporation (transpiration),

Lenticular transpiration

Lenticels are special openings that develop on the barks of older stems in place of stomata. Lenticels never close. They remain open all the time. The amount of transpiration from lenticels is certainly less than the cuticular transpiration, and very much less than the stomatal transpiration.

FACTORS THAT AFFECT TRANSPIRATION

A. EXTERNAL FACTORS

1. Intensity of Sunlight: During the day, the stomata are open to facilitate the inward diffusion of CO_2, for photosynthesis. At night they are closed.

2. Temperature: If the outside temperature is higher, there is more evaporation from the leaves, therefore, more transpiration. Increase in temperature allows more water to evaporate and the decrease in temperature reduces evaporation.

3. Velocity of wind: Transpiration increases with the velocity of wind. If the wind blows faster, the water vapour released during transpiration is removed faster and the area outside the leaf does not get saturated with water vapour.

4. Humidity: Transpiration is reduced if the air outside is humid. High humidity in the air reduces the rate of outward diffusion of the internal water vapour across stomata, thereby reducing the rate of transpiration.

5. Carbon dioxide: Increase in the CO, level in the outside air over normal 0.03% causes stomatal closure and results in the decrease of transpiration.

6. Atmospheric pressure: Rate of transpiration increases with the decrease in atmospheric pressure.

B. INTERNAL FACTOR

Water content of the leaves: If the water content of the leaves decreases due to insufficient absorption of water by the roots, the leaves wilt and transpiration is reduced. Such reduction in transpiration is indirectly due to the closure of stomata and it is a natural mechanism of conserving water within the plant.

ADAPTATIONS IN PLANTS TO REDUCE EXCESSIVE TRANSPIRATION

1. Sunken stomata : The stomata may be sunken or covered by hairs (e.g. Nerium).

2. Fewer stomata: The number of stomata may be reduced.

3. Narrow leaves: The leaves may become narrower to reduce surface area (e.g. Nerium).

4. Reduced exposed surfaces: In some cases, leaves may get wavy, rolled or folded to reduce exposed surface.

5. Loss of leaves: In some cases, leaves may be dropped or may be absent or changed into spines as in most cacti.

6. Thick cuticle: The leaves may be covered by thick cuticle, e.g. Banyan, and most evergreen trees.

SIGNIFICANCE OF TRANSPIRATION

1. Cooling effect: Evaporation reduces temperature of leaf surface. Therefore, transpiration is useful to plants on hot sunny days. (At intense heat, the enzymes are destroyed).

2. Suction force: Transpiration helps in the ascent of sap by producing a suction force acting from the top of a plant. Evaporation from the leaves concentrates cell sap and increases their osmotic pressure.

3. Distribution of water and mineral salts :- Higher the rate of transpiration, greater the rate of absorption of water and solutes from the soil.

Q. Is transpiration an excretory process in the plants?.....No!

It is not appropriate to relate transpiration to excretion or just the elimination of "excess water". Excretion wherever it occurs, is a deliberate active process carried out by the organism to get rid of unwanted and metabolic waste substances.

Transpiration affects climate :-

- A full grown single sunflower plant is estimated to lose about half a litre of water per day in the form of water vapour.
- A single maize plant loses about 2 litres of water per day.
- A large apple tree may lose about 30 litres of water per day.

Thus, transpiration increases the moisture in the atmosphere and brings rain. In this way, transpiration from plants affects climate.

Forests contribute in bringing rain ------- Transpiration is the secret.

GUTTATION AND BLEEDING

Some plants may lose water or other fluids along with dissolved substances directly in liquid form and not as water vapour. This is known as exudation (to exude means to ooze or sweat out) and the fluid given out is known as an exudate. It occurs in two ways guttation and bleeding.

Guttation (gutta: to pour out, to drop): The leaves of certain plants exhibit droplets of water along their margins in the morning.

Special pore-bearing structures called hydathodes are present on the margins of the leaf to allow this exudation.Ex- banana, nastrium and strawberry.

Bleeding: This happens only due to injury. The plant sap and sugar escapes ("bleeds") from the ruptured or cut surfaces of a plant. The root pressure generated by a plant assists in bleeding.